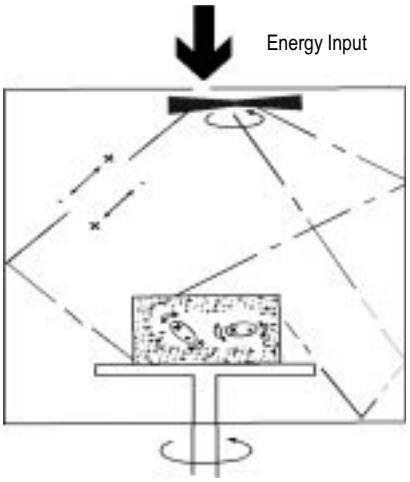
Applied Technology: Microwave



Concept

Microwaves are electromagnetic waves in the frequency range of 300 to 3,000 megahertz (MHz, million cycles per second) generated by a magnetron-type vacuum tube. Electromagnetic energy at 915 and 2,450 MHz can be absorbed by materials containing water or other "lossy" substances, such as carbon and some organics, and converted to heat. Because the waves can penetrate to the interior of the material, heating is volumetric ("from the inside out"). The degree of penetration and rate of heat generation depend on the selected frequency and the dielectric characteristics of the material, as well as the power rating of the generator. Microwaves can heat certain products selectively. In drying, more uniform moisture profiling in the product is possible.

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Applications

- Drying, Tempering, Proofing, Precooking, Pasteurization of foods
- Preheating and curing of rubber
- Recycling spent asphalt paving
- Drying of foundry molds
- Drying and sintering ceramics
- Plasma etching semiconductors

Technologies Replaced

- Gas fired drying and curing ovens
- Salt-bath curing of rubber
- Wet-chemical etching semiconductors
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- Salt-bath curing of rubber
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Wastes Reduced

- Combustion Pollutants; ROG, SOx, NOx, COx, Particulate
- Equipment corrosion from salt vapors
- Startup product quality losses
- Wastewater in food processing
- Wet-chemical etch haz chemicals
- Used asphalt and virgin asphalt emissions

Potential in Manufacturing

Indust	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*
Food	**20**	**HI**	Lumber	24	LOW	Chem	28	MED	Stone	32	MED	**Elect**	**36**	**HI**
Tobac	21	MED	Furn	25	LOW	Petrol	29	LOW	Pmetal	33	MED	Transp	37	LOW
Textile	22	LOW	Paper	26	LOW	Rubber	30	MED	MetFab	34	LOW	Instr	38	LOW
Apparel	23	LOW	Printing	27	LOW	Leather	31	LOW	Mach	35	LOW	Misc	39	LOW

Credits: **: Dr. Philip Schmidt and Dr. F.T. Sparrow;**
Unimar Group, Ltd; The Electrification Council; Electric Power Research Institute

Microwave ***continued***

Technology Advantages

- Fast heating, startup and shutdown
- Can dry to consistent levels
- High energy efficiency
- High quality and controllability
- Compact, easy to clean equipment
- Low emissions
- Can heat in vacuum or low temperature

Technology Disadvantages

- Product can overheat
- Not as tolerant of product variability or geometry as convection
- Will not work on all products
- Higher capital cost
- Requires specialized technical support

Typical Costs

Capital Costs	O & M Costs	Potential Payback
High: $2k - $4k per kW	low to moderate operating, high maintenance	1 - 2 years

Installations

Case A - A number of U.S. pasta producers have installed microwave-enhanced drying ovens for drying of short-goods products. The microwave ovens require less than one-fifth the floor area of conventional drying ovens for the same throughput and have often been selected to expand production capacity within a constrained space environment. The microwave process decreases both fuel and electricity requirements and their associated emissions; overall fuel costs are reduced by about 30%. Because of their ability to come on-line and off-line in a matter of minutes, the microwave units provide an increase in output of about 6% in a typical 2-shift production day, compared with conventional gas-fired dryers which take longer to heat up and cool down.

Case B - A new process has been developed using microwaves to reclaim asphalt pavement that has been stripped from the surface of roadways. The asphalt in paving mix is virtually transparent to microwaves, while the crushed stone aggregate, which constitutes 95% of the mix, is readily heated. A plant which has been running for several years in Los Angeles, processing 1000 tons/day of reclaimed paving mix, has produced recycled asphalt at $15/ton, compared with $22-28/ton for virgin mix. Recycling the paving mix eliminates the land-fill costs associated with disposal of spent paving and the plant operates with none of the liquid and gaseous effluents associated with conventional asphalt production plants.

Major Vendors

Microwave

AGL, Inc.
(*semiconductor plasma processing*)
1132 Doker Drive
Modesto, CA 95351
(209) 521-6549

Amana Refrigeration, Inc
Industrial Microwave Division
2800 220th Trail
Amana, IA 52204
(319) 622-5850

Berstorff Corporation
8200 Arrowridge Blvd.
Charlotte, NC 28273
(704) 523-2614

Cober Electronics, Inc
102 Hamilton Avenue
Stamford. CT 06902
(203) 327-0003

Microdry
7450 Highway 329
Crestwood, KY 40014
(502) 241-8933

Nemeth Engineering Associates
5901 W. Highway 22
Crestwood, KY 40014
(502) 241-1502

Sanitec (*medical waste*)
26 Fairfield Place
West Caldwell, NJ 07006
(800) 551-9897

Thermex-Thermetron, Inc.
60 Spence Street
Bayshore, NY 11706
(516) 231-7800

This list of vendors of the indicated technology is not meant to be a complete or comprehensive listing. Mention of any product, process, service, or vendor in this publication is solely for educational purposes and should not be regarded as an endorsement by the authors or publishers.

Index to EPRI DOCUMENTS

Microwave

Dielectric Heating: RF and Microwave, EPRI CMF TechCommentary, Vol 4, No 1, 1990

Industrial Microwave Heating Applications, EPRI CMF TechCommentary, Vol 4, No 3R, 1993

Microwave Curing of Rubber, EPRI CMF TechApplication, Vol 2, No 1, 1988

Microwave Process for Asphalt Pavement Recycling, EPRI CEC TechApplication, No 2, 1992

Food Processing Using Microwaves, EPRI PIO TechApplication, Vol 2, No 1, 1990

Microwave Curing of Lumber Adhesives, EPRI PIO TechApplication, Vol 6, No 1, 1994

This information is designed to help you determine **potential** applications for the technology. You are encouraged to contact one of the listed vendors or a consultant for details and pricing.

This manual is not intended as a recommendation of any particular technology, process, or method. Mention of trade names, vendors, or commercial products do not constitute endorsement or recommendation for use. It is offered for educational and informational purposes and is advisory only.

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